SIEMENS

SIMATIC

S7-1500

Analog input module AI 8xU/I HS (6ES7531-7NF10-0AB0)

Manual

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Answers for industry.

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SIMATIC

S7-1500/ET 200MP Analog Input Module AI 8xU/I HS (6ES7531-7NF10-0AB0)

Manual

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Preface

Purpose of the documentation

This manual supplements the system manuals:

- S7-1500 Automation System
- ET 200MP Distributed I/O System

Functions that relate in general to the systems are described in these system manuals.

The information provided in this manual and in the system/function manuals supports you in commissioning the systems.

Changes compared to previous version

Changes described in this manual, compared to the previous version:

- Module integrated in hardware catalog STEP 7 (TIA Portal) V13, Update 3 or higher with the functions:
  - Module-internal shared input (MSI) for Shared Device
  - Configurable submodules, e.g., for Shared Device
- Appendix Open Source Software amended

Conventions

The term "CPU" is used in this manual both for the CPUs of the S7-1500 automation system, as well as for interface modules of the ET 200MP distributed I/O system.

Please also observe notes marked as follows:

Note

A note contains important information regarding the product described in the documentation or its handling, or draws special attention to a section of the documentation.

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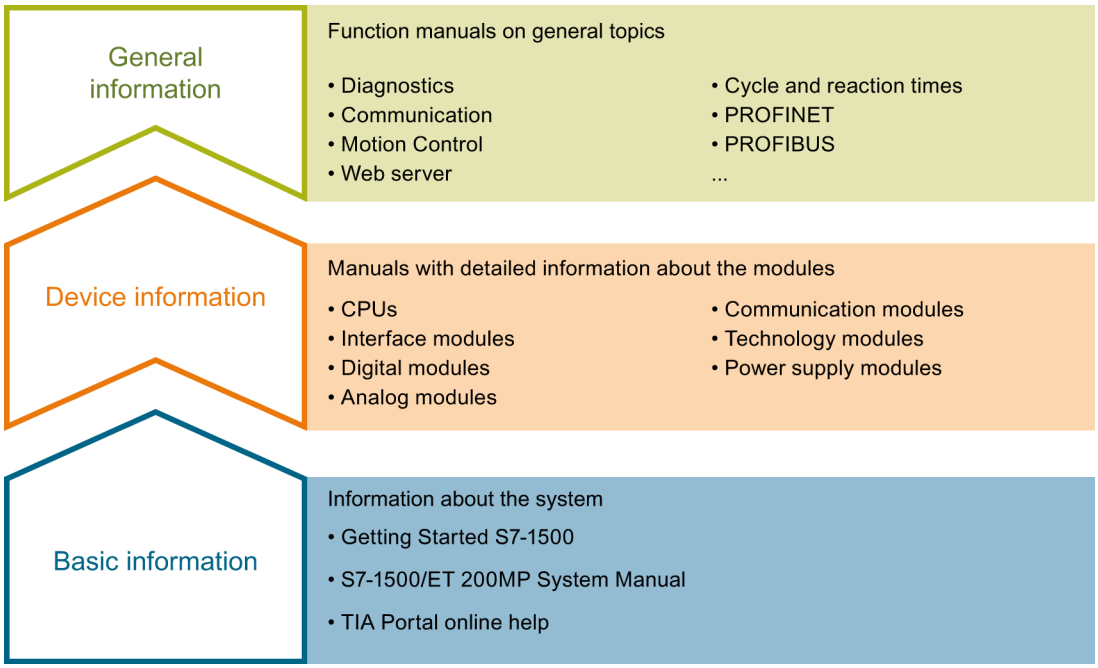
Documentation guide

1

The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP distributed I/O system is arranged into three areas.
This arrangement enables you to access the specific content you require.



Basic information

System Manual and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500 and ET 200MP systems. The STEP 7 online help supports you in the configuration and programming.

Device information

Manuals contain a compact description of the module-specific information, such as properties, terminal diagrams, characteristics, technical specifications.

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC S7-1500 and ET 200MP systems, e.g. diagnostics, communication, Motion Control, Web server.

You can download the documentation free of charge from the Internet (http://www.automation.siemens.com/mcms/industrial-automation-systems-simatic/en/manual-overview/tech-doc-controllers/Pages/Default.aspx).

Changes and supplements to the manuals are documented in a Product Information.

Manual Collection S7-1500 / ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the ET 200MP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (http://support.automation.siemens.com/WW/view/en/86140384).

My Documentation Manager

The My Documentation Manager is used to combine entire manuals or only parts of these to your own manual.
You can export the manual as PDF file or in a format that can be edited later.

You can find the My Documentation Manager on the Internet (http://support.automation.siemens.com/WW/view/en/38715968).

Applications & Tools

Applications & Tools supports you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus in individual products.

You can find Applications & Tools on the Internet (http://support.automation.siemens.com/WW/view/en/20208582).

CAx Download Manager

The CAx Download Manager is used to access the current product data for your CAx or CAe systems.

You configure your own download package with a few clicks.

In doing so you can select:

- Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files
- Manuals, characteristics, operating manuals, certificates
- Product master data

You can find the CAx Download Manager on the Internet (http://support.automation.siemens.com/WW/view/en/42455541).

Product overview

2

2.1 Properties

Article number

6ES7531-7NF10-0AB0

View of the module

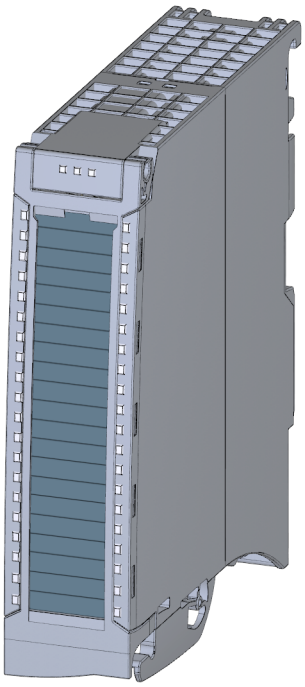


Figure 2-1 View of the AI 8xU/I HS module

Properties

The module has the following technical properties:

- 8 analog inputs
- Voltage or current measuring type can be set per channel
- Resolution 16 bits including sign
- Configurable diagnostics (per channel)
- Hardware interrupt on limit violation can be set per channel (two low and two high limits per channel)
- High-speed update of measured values

The module supports the following functions:

Table 2- 1 Version dependencies of the module functions

Function	Firmware version of the module	Configuration software	
		STEP 7 (TIA Portal)	GSD file in STEP 7 (TIA Portal) V12 or higher, or STEP 7 V5.5 SP3 or higher
Firmware update	V1.0.0 or higher	V12 or higher	X
Identification data I&M0 to I&M3	V1.0.0 or higher	V12 or higher	X
Parameter assignment in RUN	V1.0.0 or higher	V12 or higher	X
Isochronous mode	V1.0.0 or higher	V12 or higher	---
Calibration in runtime	V1.0.0 or higher	V12 or higher	X
Module-internal Shared Input (MSI)	V2.0.0 or higher	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
Configurable submodules / submodules for Shared Device	V2.0.0 or higher	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
Configurable after interface module IM 155-5 DP ST	V2.0.0 or higher	V13 or higher	X

You can configure the module with STEP 7 (TIA Portal) and with a GSD file.

Accessories

The following accessories are supplied with the module and can also be ordered separately as spare parts:

- Shield bracket
- Shield terminal
- Power supply element
- Labeling strips
- U connector
- Universal front door

Other components

The following component must be ordered separately:

Front connectors, including potential jumpers and cable ties

You can find more information on accessories in the S7-1500 Automation System system manual (http://support.automation.siemens.com/WW/view/en/59191792) and the ET 200MP Distributed I/O System system manual (http://support.automation.siemens.com/WW/view/en/59193214).

Wiring

3

The section below includes the block diagram of the module and various wiring options. For more information on front connector wiring and creating cable shields, for example, refer to the "Wiring" section in the S7-1500 Automation System (http://support.automation.siemens.com/WW/view/en/59191792) and ET 200MP Distributed I/O System (http://support.automation.siemens.com/WW/view/en/59193214) system manuals.

Note

You may use and combine the different wiring options for all channels.

Note

Do not insert the potential jumpers included with the front connector!

Abbreviations used

Meaning of the abbreviations used in the following figures:

U_n+/U_n-	Voltage input channel n (voltage only)
I_n+/I_n-	Current input channel n (current only)
U_{Vn}	Supply voltage at channel n for 2-wire transmitters (2WT)
L+	Supply voltage connection
M	Ground connection
M_{ANA}	Reference potential of the analog circuit
CHx	Channel or display of the channel status
PWR	Display for the supply voltage

Pin assignment for the power supply element

The power supply element is plugged onto the front connector for powering the analog module. Wire the supply voltage to terminals 41 (L+) and 44 (M). Use terminals 42 (L+) and 43 (M) to loop the potential to the next module.

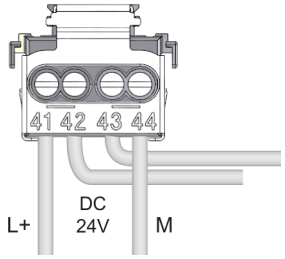
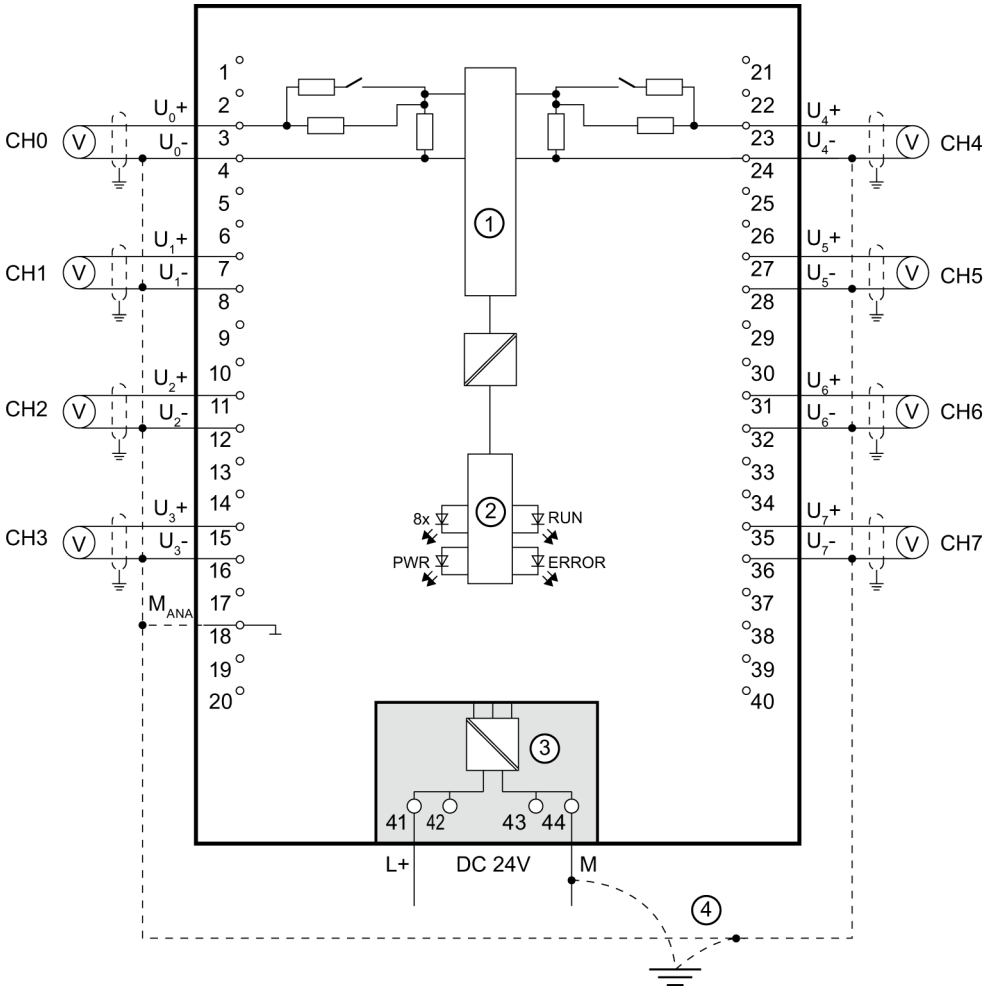


Figure 3-1 Power supply element wiring

Block diagram and pin assignment for voltage measurement

The example in the figure below shows the pin assignment for a voltage measurement.

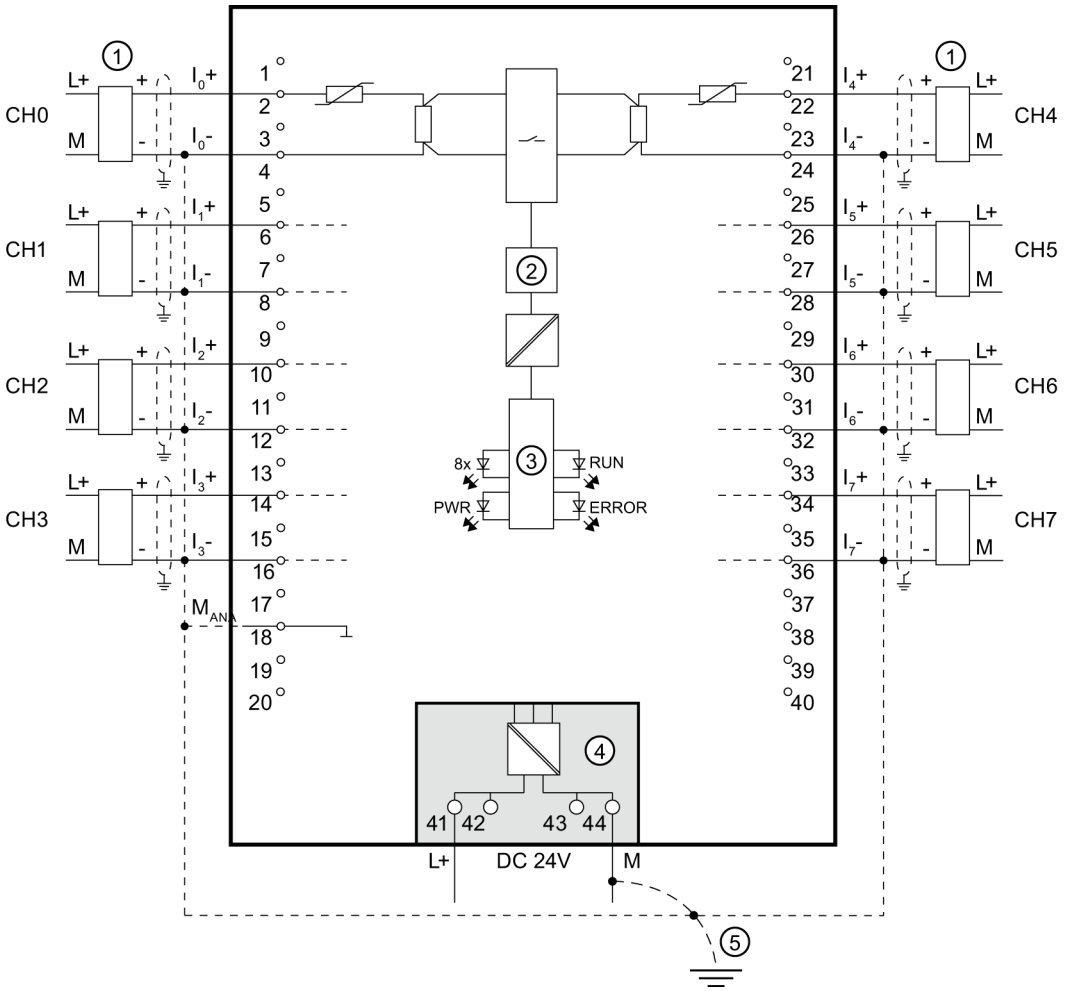


① Analog-to-Digital Converter (ADC)
② Backplane bus interface
③ Supply voltage via power supply element
④ Equipotential bonding cable (optional)

Figure 3-2 Block diagram and pin assignment for voltage measurement

Block diagram and pin assignment for 4-wire transmitter for current measurement

The example in the following figure shows the pin assignment for current measurement with 4-wire transmitters.

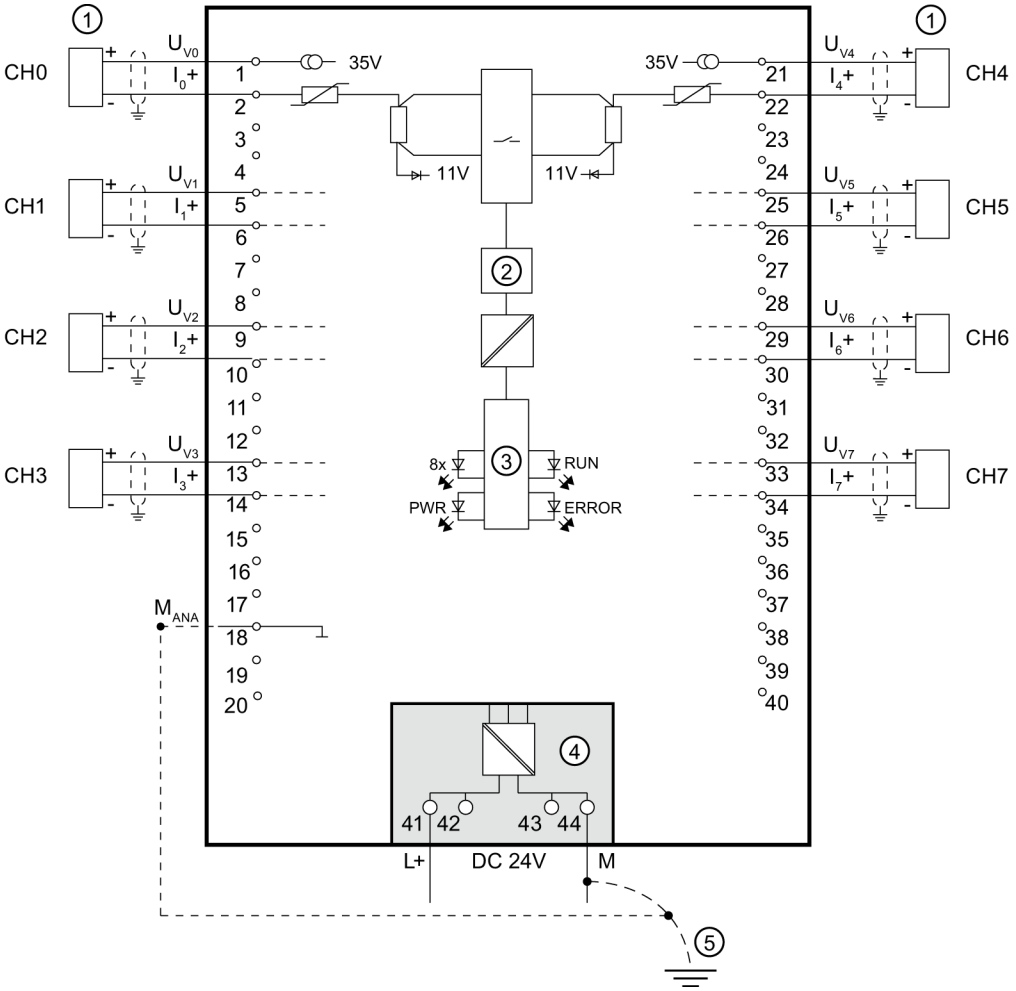


① Wiring 4-wire transmitter
② Analog-to-Digital Converter (ADC)
③ Backplane bus interface
④ Supply voltage via power supply element
⑤ Equipotential bonding cable (optional)

Figure 3-3 Block diagram and pin assignment for 4-wire transmitter for current measurement

Block diagram and pin assignment for 2-wire transmitter for current measurement

The example in the following figure shows the pin assignment for current measurement with 2-wire transmitters.



① Wiring 2-wire transmitter
② Analog-to-Digital Converter (ADC)
③ Backplane bus interface
④ Supply voltage via power supply element
⑤ Equipotential bonding cable (optional)

Figure 3-4 Block diagram and pin assignment for 2-wire transmitter for current measurement

Parameters/address space

4

4.1 Measuring types and ranges

Introduction

The module is set to voltage measuring type with measuring range ±10 V by default. You need to reassign the module parameters with STEP 7 if you want to use a different measuring type or range.

The following table shows the measuring types and the respective measuring range.

Measuring type	Measuring range
Voltage	1 V to 5 V ±5 V ±10 V
Current 2WMT (2-wire transmitter)	4 mA to 20 mA
Current 4WMT (4-wire transmitter)	4 mA to 20 mA 0 mA to 20 mA ±20 mA
Deactivated	-

The tables of the input ranges, overflow, undershoot range, etc. are available in appendix Representation of analog values (Page 44).

4.2 Parameters

Parameters of the AI 8xU/I HS

When you assign the module parameters in STEP 7, you use various parameters to specify the module properties. The following table lists the configurable parameters. The effective range of the configurable parameters depends on the type of configuration. The following configurations are possible:

- Central operation with a S7-1500 CPU
- Distributed operation on PROFINET IO in an ET 200MP system
- Distributed operation on PROFIBUS DP in an ET 200MP system

When assigning parameters in the user program, use the WRREC instruction to transfer the parameters to the module by means of data records; refer to the section Parameter assignment and structure of the parameter data records (Page 38).

The following parameter settings are possible:

Table 4- 1 Configurable parameters and their defaults

Parameters	Range of values	Default setting	Parameter assignment in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP
Diagnostics					
• Missing supply voltage L+	Yes/No	No	Yes	Channel [1]	Module [3]
• Overflow	Yes/No	No	Yes	Channel	Module [3]
• Underflow	Yes/No	No	Yes	Channel	Module [3]
• Wire break	Yes/No (Voltage: 1 V to 5 V Current: 4 mA to 20 mA)	No	Yes	Channel	Module [3]
• Current limit for wire break diagnostics [2]	1.185 mA or 3.6 mA	1.185 mA	Yes	Channel	--- [4]
Measuring					
• Measuring type	See chapter Measuring types and ranges (Page 16)	Voltage	Yes	Channel	Channel
• Measuring range		±10 V	Yes	Channel	Channel
• Smoothing	None/low/medium /high	None	Yes	Channel	Channel
Hardware interrupt					
• Hardware interrupt high limit 1	Yes/No	No	Yes	Channel	--- [4]

Parameters	Range of values	Default setting	Parameter assignment in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP
• Hardware interrupt low limit 1	Yes/No	No	Yes	Channel	--- 4)
• Hardware interrupt high limit 2	Yes/No	No	Yes	Channel	--- 4)
• Hardware interrupt low limit 2	Yes/No	No	Yes	Channel	--- 4)

1) If you enable diagnostics for multiple channels, you will receive an alarm surge on failure of the supply voltage because each enabled channel will detect this fault.

You can prevent this message burst by assigning the diagnostics function to one channel only.

2) When "Wire break" diagnostics is disabled, the current limit of 1.185 mA is applied to the value status. For measured values below 1.185 mA, the value status is always: 0 = fault.

3) You can set the effective range of the diagnostics for each channel in the user program with data records 0 to 7.

4) You can set the current limit for wire break diagnostics, the "Hardware interrupt" parameter and the hardware interrupt limits in the user program with data records 0 to 7.

4.3 Declaration of parameters

Missing supply voltage L+

Enabling of the diagnostics, with missing or too little supply voltage L+.

Overflow

Enabling of the diagnostics if the measured value violates the high limit.

Underflow

Enabling of the diagnostics if the measured value violates the low limit.

Wire break

Enabling of the diagnostics if the module has no current flow or the current is too weak for the measurement at the corresponding configured input or the applied voltage is too low.

Current limit for wire break diagnostics

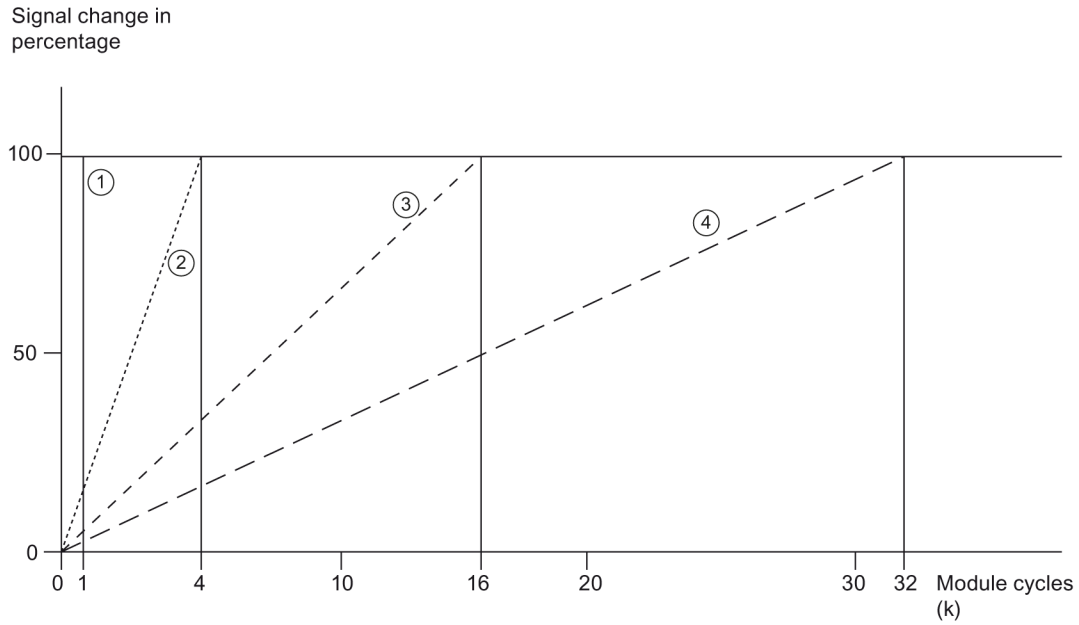
Threshold for reporting wire breaks. The value can be set to 1.185 mA or 3.6 mA, depending on the sensor used.

Smoothing

The individual measured values are smoothed using filtering. The smoothing can be set in 4 levels.

Smoothing time = number of module cycles (k) x cycle time of the module.

The following figure shows after how many module cycles the smoothed analog value is almost 100%, depending on the set smoothing. Is valid for each signal change at the analog input.



① None (k = 1)
② Weak (k = 4)
③ Medium (k = 16)
④ Strong (k = 32)

Figure 4-1 Smoothing with AI 8xU/I HS

Hardware interrupt 1 or 2

Enable a hardware interrupt at violation of high limit 1 or 2 or low limit 1 or 2.

Low limit 1 or 2

Specifies the low limit threshold that triggers hardware interrupt 1 or 2.

High limit 1 or 2

Specifies the high limit threshold that triggers hardware interrupt 1 or 2.

4.4 Address space

The module can be configured differently in STEP 7; see following table. Depending on the configuration, additional/different addresses are assigned in the process image of the inputs.

Configuration options of AI 8xU/I HS

You can configure the module with STEP 7 (TIA Portal) or with a GSD file.

When you configure the module by means of the GSD file, the configurations are available under different abbreviations/module names.

The following configurations are possible:

Table 4- 2 Configuration options

Configuration	Short designation/ module name in the GSD file	Configuration software, e.g., with STEP 7 (TIA Portal)	
		Integrated in hardware catalog STEP 7 (TIA Portal)	GSD file in STEP 7 (TIA Portal) V12 or higher or STEP 7 V5.5 SP3 or higher
1 x 8-channel without value status	AI 8xU/I HS	V12 or higher	X
1 x 8-channel with value status	AI 8xU/I HS QI	V12 or higher	X
8 x 1-channel without value status	AI 8xU/I HS S	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
8 x 1-channel with value status	AI 8xU/I HS S QI	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel with value status for module-internal shared input with up to 4 submodules	AI 8xU/I HS MSI	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)

Value status (Quality Information, QI)

The value status is always activated for the following module names:

- AI 8xU/I HS QI
- AI 8xU/I HS S QI
- AI 8xU/I HS MSI

An additional bit is assigned to each channel for the value status. The value status bit indicates if the read in digital value is valid. (0 = value is incorrect).

Address space of AI 8xU/I HS

The following figure shows the address space allocation for the configuration as 8-channel module. You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

"IB x", for example represents the module start address input byte x.

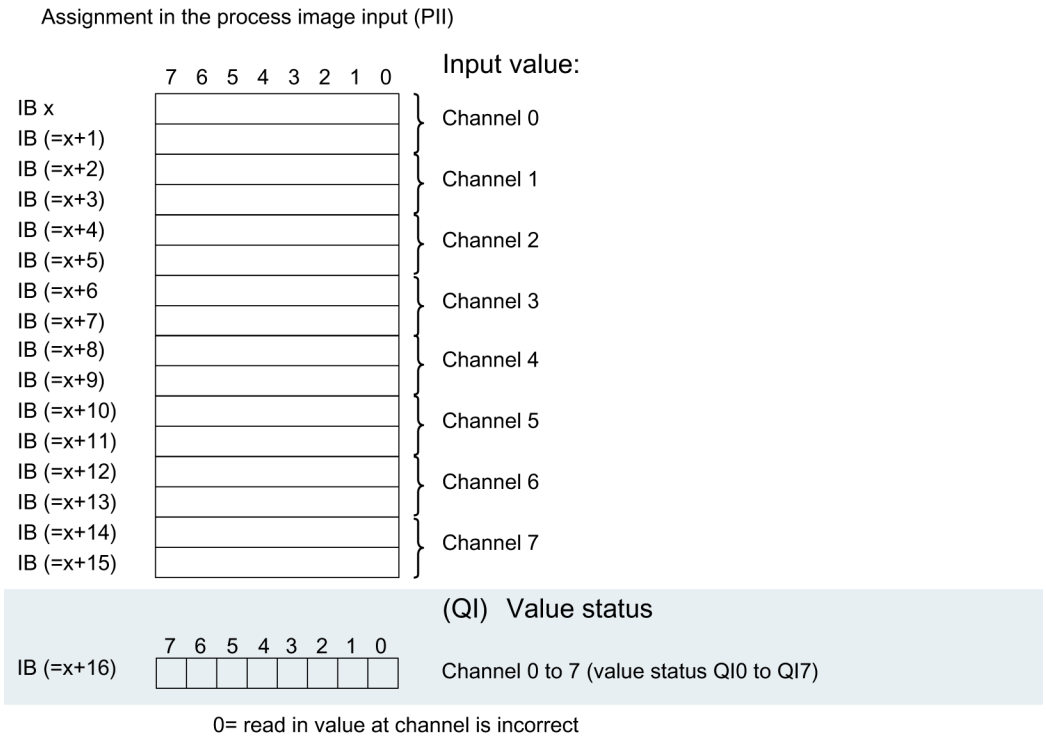


Figure 4-2 Address space for configuration as 1 x 8-channel AI 8xU/I HS with value status

Address space for configuration as 8 x 1-channel AI 8xU/I HS S QI

For the configuration as a 8 x 1-channel module, the channels of the module are divided into multiple submodules. The submodules can be assigned to different IO controllers when the module is used in a shared device.

The number of usable submodules is dependent on the interface module used. Observe the information in the manual for the particular interface module.

Contrary to the 1 x 8-channel module configuration, each of the eight submodules has a freely assignable start address.

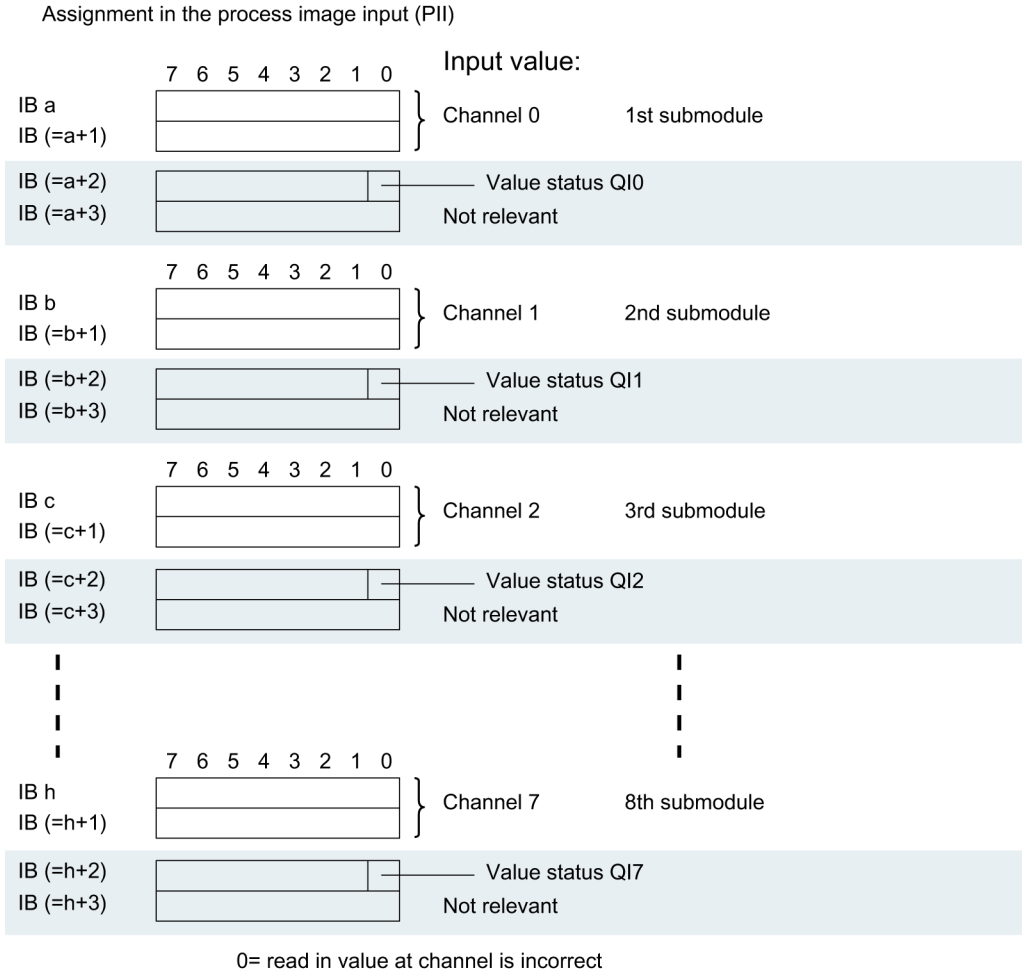


Figure 4-3 Address space for configuration as 8 x 1-channel AI 8xU/I HS S QI with value status

Address space for configuration as 1 x 8-channel AI 8xU/I HS MSI

The channels 0 to 7 of the module are copied in up to four submodules with configuration 1 x 8-channel module (Module-internal shared input, MSI). Channels 0 to 7 are then available with identical input values in different submodules. These submodules can be assigned to up to four IO controllers when the module is used in a shared device. Each IO controller has read access to the same channels.

The number of usable submodules is dependent on the interface module used. Please observe the information in the manual for the particular interface module.

Value status (Quality Information, QI)

The meaning of the value status depends on the submodule on which it occurs.

For the first submodule (=basic submodule), the value status 0 indicates that the value is incorrect.

For the 2nd to 4th submodule (=MSI submodule), the value status 0 indicates that the value is incorrect or the basic submodule has not yet been configured (not ready).

The following figure shows the assignment of the address space with submodules 1 and 2.

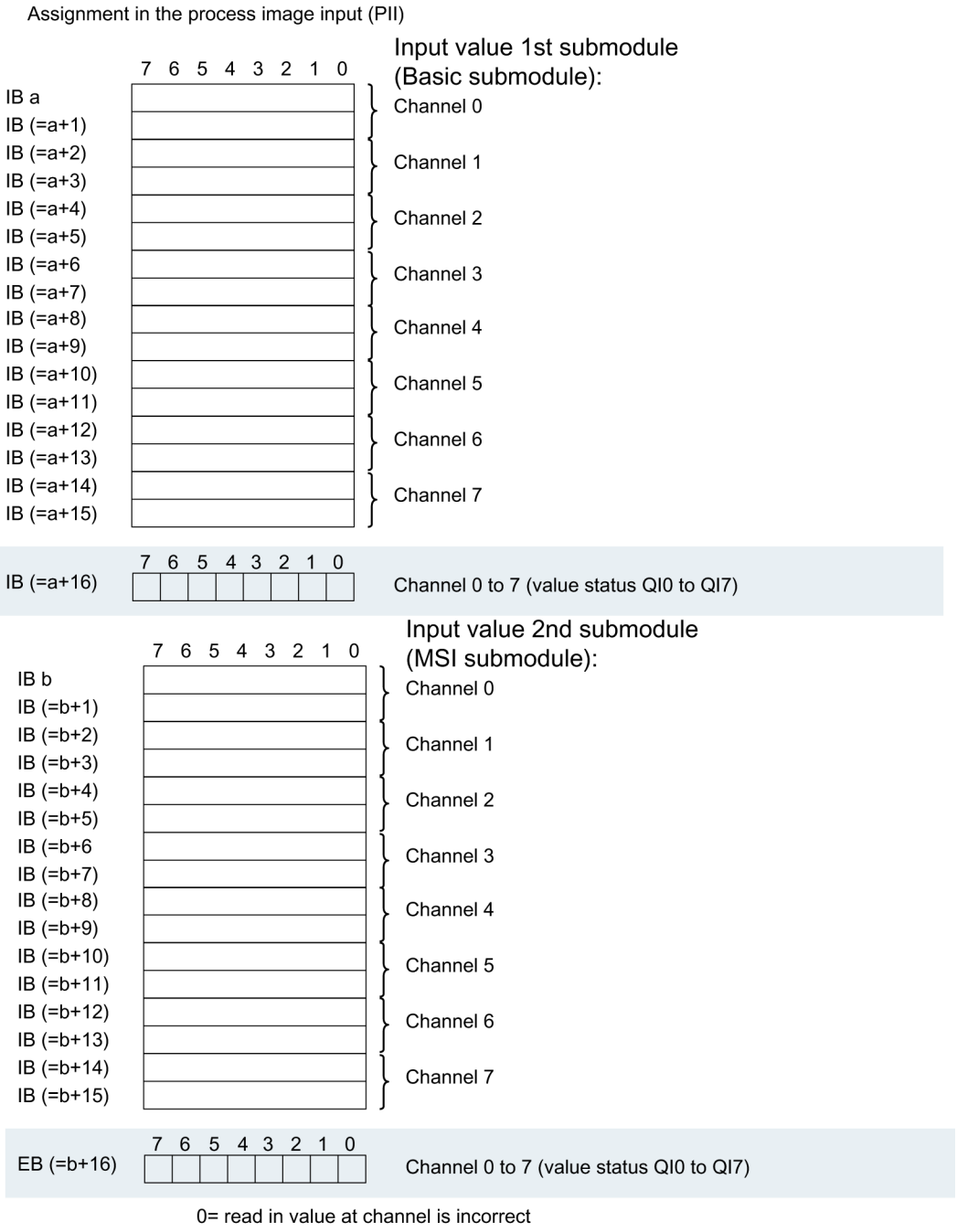


Figure 4-4 Address space for configuration as 1 x 8-channel AI 8xU/I HS MSI with value status

The following figure shows the assignment of the address space with submodules 3 and 4.

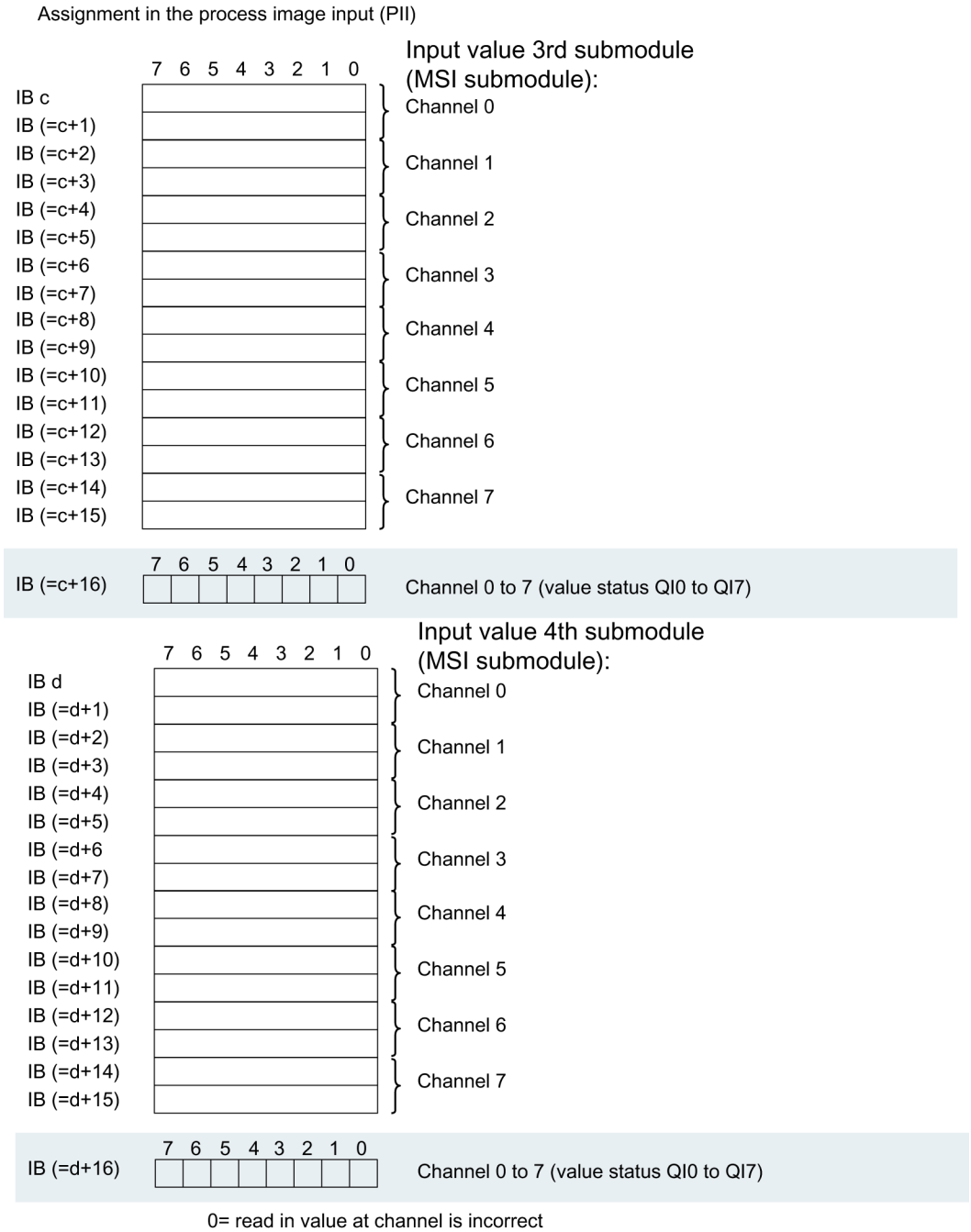


Figure 4-5 Address space for configuration as 1 x 8-channel AI 8xU/I HS MSI with value status

Interrupts/diagnostics alarms

5

5.1 Status and error displays

LED displays

The following figure shows the LED displays (status and error displays) of AI 8xU/I HS.

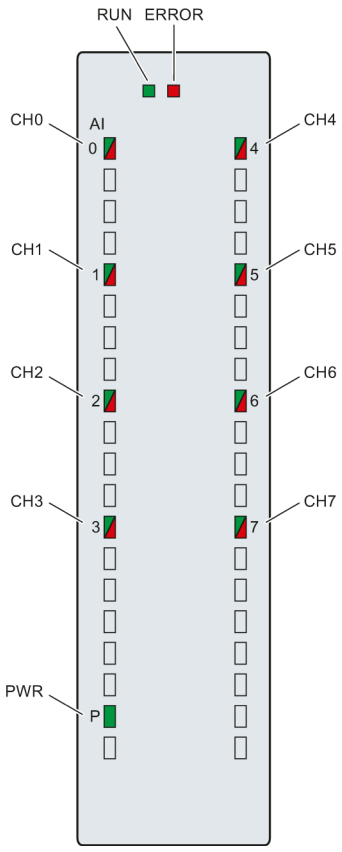


Figure 5-1 LED displays of the module AI 8xU/I HS

Meaning of the LED displays

The following tables explain the meaning of the status and error displays. Remedial measures for diagnostic alarms can be found in section Diagnostic alarms.

RUN and ERROR LED

Table 5- 1 Status and error displays RUN and ERROR

LED		Meaning	Remedy
RUN	ERROR		
Off	Off	Voltage missing or too low at backplane bus.	• Switch on the CPU and/or the system power supply modules. • Verify that the U connectors are inserted. • Check to see if too many modules are inserted.
Flashes	Off	The module starts and flashes until the valid parameter assignment is set.	---
On	Off	Module is configured.	
On	Flashes	Indicates module errors (at least one error at one channel, e.g., wire break).	Evaluate the diagnostics data and eliminate the error (e.g., wire break).
Flashes	Flashes	Hardware defective.	Replace the module.

PWR LED

Table 5- 2 PWR status display

LED PWR	Meaning	Remedy
Off	Supply voltage L+ to module too low or missing	Check supply voltage L+.
On	Supply voltage L+ is present and OK.	---

CHx LED

Table 5- 3 CHx status display

LED CHx	Meaning	Remedy
□ Off	Channel disabled	---
■ On	Channel configured and OK.	---
■ On	Channel is configured (channel error pending). Diagnostic alarm: e.g. wire break	Check the wiring. Disable diagnostics.

See also

Diagnostics alarms (Page 31)

5.2 Interrupts

Analog input module AI 8xU/I HS supports the following diagnostic and hardware interrupts.

Diagnostic interrupt

The module generates a diagnostic interrupt at the following events:

- Missing supply voltage L+
- Wire break
- Overflow
- Underflow

Hardware interrupt

The module generates a hardware interrupt at the following events:

- Low limit violated 1
- High limit violated 1
- Low limit violated 2
- Violation of high limit 2

For detailed information on the error event, refer to the hardware interrupt organization block with the "RALRM" instruction (read additional interrupt info) and to the STEP 7 online help.

The module channel that triggered the hardware interrupt is entered in the start information of the organization block. The diagram below shows the assignment to the bits of double word 8 in local data.

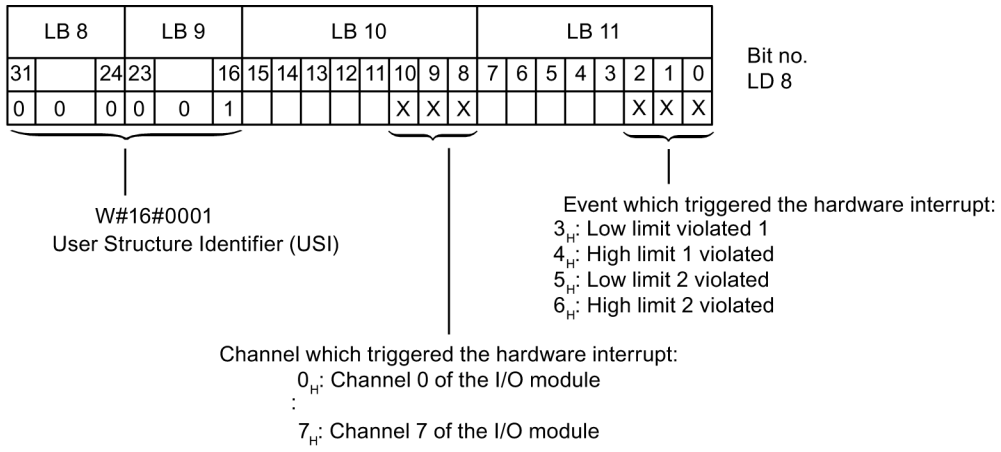

LB 8
LB 9
LB 10
LB 11
Bit no.
LD 8
31 24 23 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 1 X X X X X X
W#16#0001
User Structure Identifier (USI)
Event which triggered the hardware interrupt:
3H: Low limit violated 1
4H: High limit 1 violated
5H: Low limit 2 violated
6H: High limit 2 violated
Channel which triggered the hardware interrupt:
0H: Channel 0 of the I/O module
:
7H: Channel 7 of the I/O module

Figure 5-2 OB start information

Reaction when reaching limits 1 and 2 at the same time

If the two high limits 1 and 2 are reached at the same time, the module always signals the hardware interrupt for high limit 1 first. The configured value for high limit 2 is irrelevant. After processing the hardware interrupt for high limit 1, the module triggers the hardware interrupt for high limit 2.

The module has the same reaction when the low limits are reached at the same time. If the two low limits 1 and 2 are reached at the same time, the module always signals the hardware interrupt for low limit 1 first. After processing the hardware interrupt for low limit 1, the module triggers the hardware interrupt for low limit 2.

Structure of the additional interrupt information

Table 5- 4 Structure of USI = W#16#0001

Data block name		Contents	Remark	Bytes
USI (User Structure Identifier)		W#16#0001	Additional interrupt info for hardware interrupts of the I/O module	2
The channel that triggered the hardware interrupt follows.				
	Channel	B#16#00 to B#16#n	Number of the event-triggering channel (n = number of module channels -1)	1
It follows the error event that triggered the hardware interrupt.				
	Event	B#16#03	Low limit violated 1	1
		B#16#04	High limit violated 1	
		B#16#05	Low limit violated 2	
		B#16#06	Violation of high limit 2	

5.3 Diagnostics alarms

A diagnostics alarm is output for each diagnostics event and the ERROR LED flashes on the module. The diagnostics alarms can, for example, be read from the diagnostics buffer of the CPU. You can evaluate the error codes with the user program.

If the module is operated distributed with PROFIBUS DP in an ET 200MP system, you have the option to read out diagnostics data with the instruction RDREC or RD_REC using data record 0 and 1. The structure of the data records is available on the Internet in the "Manual for interface module IM 155-5 DP ST (6ES7155-5BA00-0AB0)".

Table 5- 5 Diagnostics alarms, their meaning and corrective measures

Diagnostics alarm	Error code	Meaning	Remedy
Wire break	6_H	Impedance of sensor circuit too high	Use a different encoder type or modify the wiring, for example, using cables with larger cross-section
		Wire break between the module and sensor	Connect the cable
		Channel not connected (open)	• Disable diagnostics • Connect the channel
Overflow	7_H	Measuring range violated	Check the measuring range
Underflow	8_H	Measuring range violated	Check the measuring range
Load voltage missing	11_H	Supply voltage L+ of the module is missing	Connect supply voltage L+ to module/channel

Diagnostics alarms with value status (QI)

If you configure the module with value status (QI), the module always checks all errors even if the respective diagnostics is not enabled. But the module cancels the inspection as soon as it detects the first error, regardless if the respective diagnostics has been enabled or not. The result may be that enabled diagnostics may not be displayed.

Example: You have enabled the diagnostics "Underflow", but the module detects the previous diagnostics "Wire break" and cancels after this error message. The "Underflow" diagnostics is not detected.

Recommendation: To ensure that all errors get diagnosed, select all check boxes under "Diagnostics".

Technical specifications

6

Technical specifications of the AI 8xU/I HS

	6ES7531-7NF10-0AB0
Product type designation	AI 8xU/I HS
General information	
Hardware version	E01
Firmware version	V2.0.0
Product function	
I&M data	Yes; IM0 to IM3
Engineering with	
STEP 7 TIA Portal can be configured/integrated as of version	V12.0 / V12.0
STEP 7 can be configured/integrated as of version	as of V5.5 SP3 / -
Operating mode	
MSI	Yes
Supply voltage	
Type of supply voltage	DC
Rated value (DC)	24 V
Valid range, low limit (DC)	20.4 V
Valid range, high limit (DC)	28.8 V
Reverse polarity protection	Yes
Input current	
Current consumption, max.	240 mA; (with 24 V DC supply)
Encoder supply	
24 V encoder supply	
Short-circuit protection	Yes
Output current, max.	53 mA
Power	
Power consumption from the backplane bus	1.2 W
Power loss	
Power loss, typ.	3.4 W
Analog inputs	
Number of analog inputs	8
Number of analog inputs with current measurement	8
Number of analog inputs for voltage measurement	8
Permissible input voltage for voltage input (destruction limit), max.	28.8 V
Permissible input current for current input (destruction limit), max.	40 mA

	6ES7531-7NF10-0AB0
Input ranges (rated values), voltages	
1 V to 5 V	Yes
Input resistance (1 V to 5 V)	50 kΩ
-10 V to +10 V	Yes
Input resistance (-10 V to +10 V)	100 kΩ
-5 V to +5 V	Yes
Input resistance (-5 V to +5 V)	50 kΩ
Input ranges (rated values), currents	
0 mA to 20 mA	Yes
Input resistance (0 mA to 20 mA)	41 Ω; (plus approx. 42 ohm for overvoltage protection by PTC)
-20 mA to +20 mA	Yes
Input resistance (-20 mA to +20 mA)	41 Ω; (plus approx. 42 ohm for overvoltage protection by PTC)
4 mA to 20 mA	Yes
Input resistance (4 mA to 20 mA)	41 Ω; (plus approx. 42 ohm for overvoltage protection by PTC)
Cable length	
Cable length shielded, max.	800 m
Analog value formation	
Integration and conversion time / resolution per channel	
Resolution with overrange (bit including sign), max.	16 bit
Basic execution time of the module (all channels enabled)	62.5 µs
Smoothing of the measured values	
Configurable	Yes
Level: None	Yes
Level: Weak	Yes
Level: Medium	Yes
Level: Strong	Yes
Encoders	
Connection of the signal encoders	
For voltage measurement	Yes
For current measurement as 2-wire transmitter	Yes
Load of 2-wire transmitter, max.	820 Ω
For current measurement as 4-wire transmitter	Yes
Errors/accuracies	
Linearity error (relative to input range)	± 0.02 %
Temperature error (relative to input range)	± 0.005 %
Crosstalk between inputs, min.	-60 dB
Repeat accuracy in steady state at 25 °C (relative to input range)	± 0.02 %

	6ES7531-7NF10-0AB0
Operational limit in overall temperature range	
Voltage, relative to input range	± 0.3 %
Current, relative to input range	± 0.3 %
Basic error limit (operational limit at 25 °C)	
Voltage, relative to input range	± 0.2 %
Current, relative to input range	± 0.2 %
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
Common mode voltage, max.	10 V
Common mode interference, min.	60 dB; (at 400Hz: 50dB)
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes
Filtering and processing time (TCI), min.	80 µs
Bus cycle time (TDP), min.	250 µs
Jitter, max.	1 µs
Interrupts/diagnostics/status information	
Interrupts	
Diagnostics interrupt	Yes
Limit interrupt	Yes; two high limits and two low limits each
Diagnostics alarms	
Diagnostics	Yes
Monitoring of supply voltage	Yes
Wire break	Yes, only for 1 V to 5 V, 4 mA to 20 mA
Overflow/underflow	Yes
Diagnostics indicator LED	
Monitoring of supply voltage	Yes; green LED
Channel status display	Yes; green LED
For channel diagnostics	Yes; red LED
For module diagnostics	Yes; red LED
Electrical isolation	
Electrical isolation of channels	
Between the channels	No
Between the channels and the backplane bus	Yes
Between the channels and the supply voltage of the electronics	Yes
Permitted potential difference	
Between the inputs (UCM)	20 V DC
Between inputs and MANA (UCM)	10 V DC
Between M internally and the inputs	75 V DC / 60 V AC
Isolation	
Isolation tested with	707 V DC

	6ES7531-7NF10-0AB0
Ambient conditions	
Operating temperature	
Horizontal mounting position, min.	0 °C
Horizontal mounting position, max.	60 °C
Vertical mounting position, min.	0 °C
Vertical mounting position, max.	40 °C
Distributed mode	
Prioritized startup	No
Dimensions	
Width	35 mm
Height	147 mm
Depth	129 mm
Weights	
Weight, approx.	200 g

Dimensional drawing

A

This appendix contains the dimensional drawing of the module installed on a mounting rail and with a shield bracket. Always adhere to the specified dimensions for installations in cabinets, control rooms, etc.

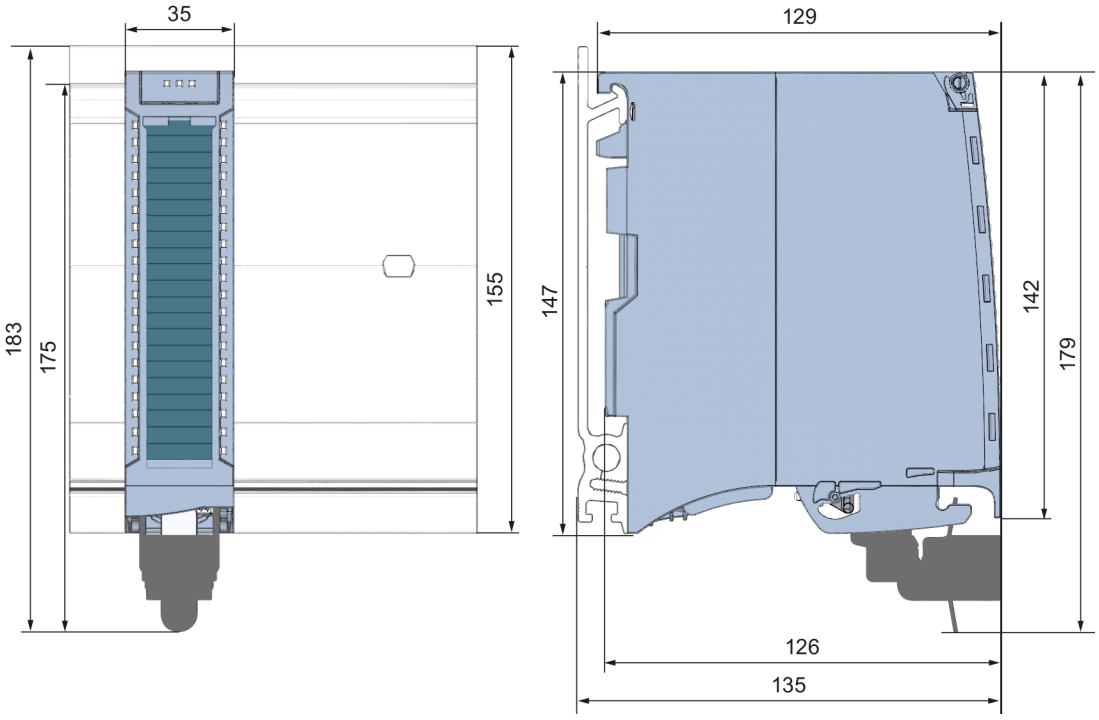


Figure A-1 Dimensional drawing of the AI 8xU/I HS module

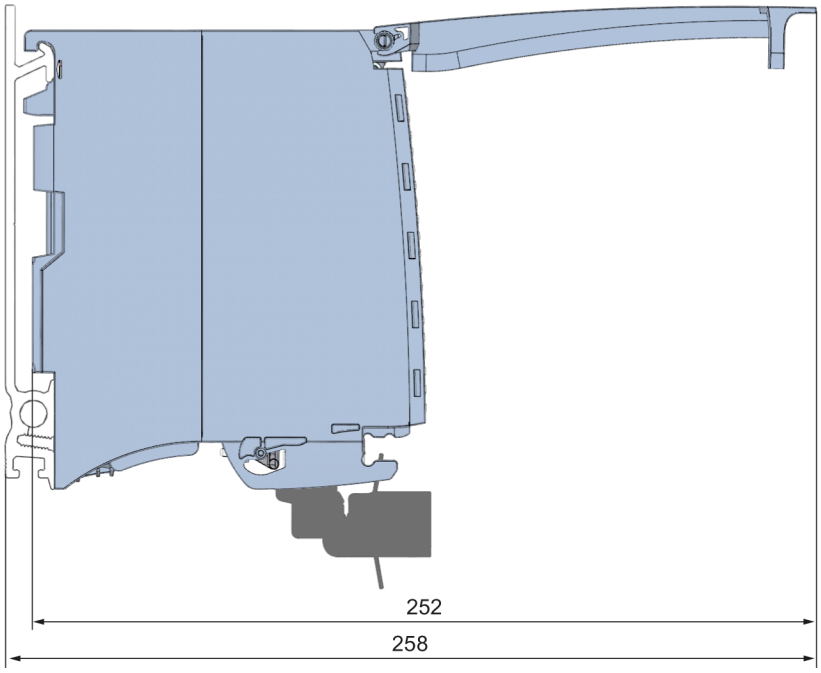


Figure A-2 Dimensional drawing of the AI 8xU/I HS module, side view with open front panel

Parameter data records

B

B.1 Parameter assignment and structure of the parameter data records

The data records of the module have an identical structure, regardless of whether you configure the module with PROFIBUS DP or PROFINET IO.

Dependencies for configuration with GSD file

When configuring the module with a GSD file, remember that the settings of some parameters are dependent on each other. The parameters are only checked for plausibility by the module after the transfer to the module.

The following table lists the parameters that depend on one another.

Table B- 1 Dependencies of parameters for configuration with GSD file

Device-specific parameters (GSD file)	Dependent parameters
Current limit for wire break	Only for **measuring type** current with **measuring range** 4 mA to 20 mA.
Wire break	Only for **measuring type** resistance with **measuring range** 1V to 5 V and current with **measuring range** 4 mA to 20 mA.
Hardware interrupt limits	Only if hardware interrupts are enabled.

Parameter assignment in the user program

You have the option to assign module parameters in RUN (e.g., the voltage or current values of selected channels can be edited in RUN without having an effect on the other channels).

Parameter assignment in RUN

The WRREC instruction is used to transfer the parameters to the module using data records 0 to 7. The parameters set in STEP 7 do not change in the CPU, which means the parameters set in STEP 7 are still valid after a restart.

The parameters are only checked for plausibility by the module after the transfer to the module.

Output parameter STATUS

The module ignores errors that occurred during the transfer of parameters with the WRREC instruction and continues operation with the previous parameter assignment. However, a corresponding error code is written to the STATUS output parameter.

The description of the WRREC instruction and the error codes is available in the STEP 7 online help.

Operation of the module behind a PROFIBUS DP interface module

If the module is operated behind a PROFIBUS DP interface module, the parameter data records 0 and 1 are not read back. You get the diagnostics data records 0 and 1 for the read back parameter data records 0 and 1. You can find more information in the Interrupts section of the PROFIBUS DP interface module device manual on the Internet (http://support.automation.siemens.com/WW/view/en/78324181).

Assignment of data record and channel

For the configuration as a 1 x 8-channel module, the parameters are located in data records 0 to 7 and are assigned as follows:

- Data record 0 for channel 0
- Data record 1 for channel 1
- …
- Data record 6 for channel 6
- Data record 7 for channel 7

For configuration 8 x 1-channel, the module has 8 submodules with one channel each. The parameters for the channel are available in data record 0 and are assigned as follows:

- Data record 0 for channel 0 (submodule 1)
- Data record 0 for channel 1 (submodule 2)
- …
- Data record 0 for channel 6 (submodule 7)
- Data record 0 for channel 7 (submodule 8)

Address the respective submodule for data record transfer.

Data record structure

The example in the following figure shows the structure of data record 0 for channel 0. The structure of channels 1 to 7 is identical. The values in byte 0 and byte 1 are fixed and may not be changed.

Enable a parameter by setting the corresponding bit to "1".

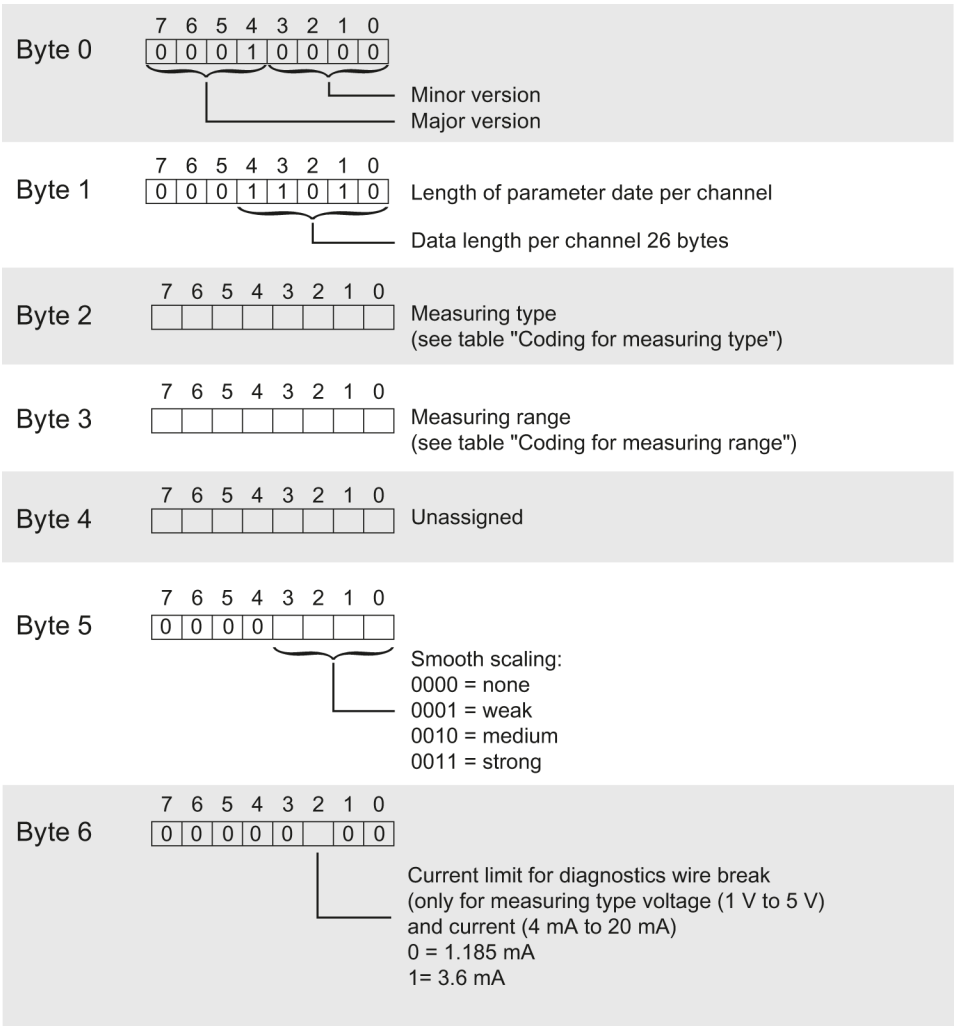
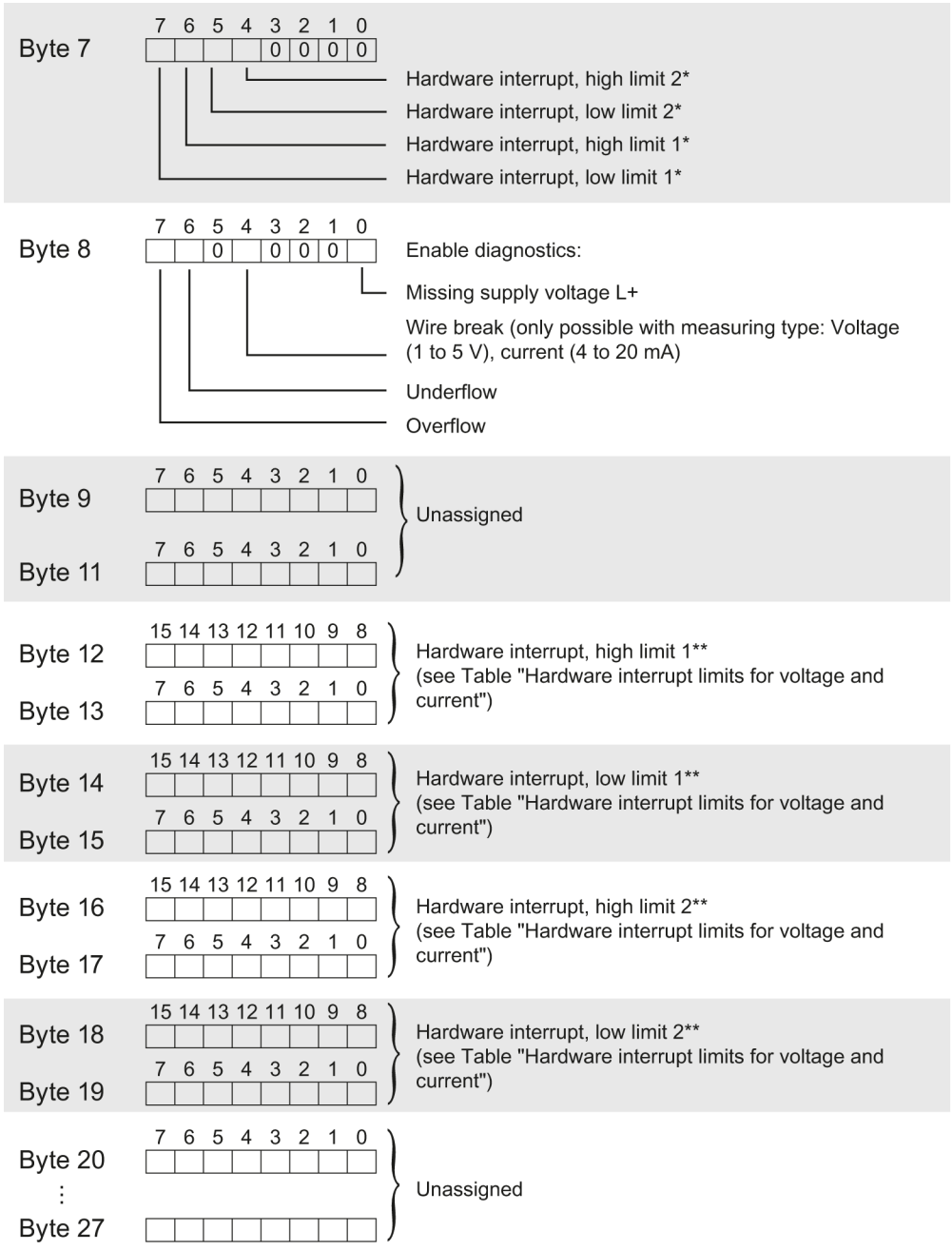

Byte 0
7 6 5 4 3 2 1 0
0 0 0 1 0 0 0 0
Minor version
Major version
Byte 1
7 6 5 4 3 2 1 0
0 0 0 1 1 0 1 0
Length of parameter date per channel
Data length per channel 26 bytes
Byte 2
7 6 5 4 3 2 1 0
Measuring type
(see table "Coding for measuring type")
Byte 3
7 6 5 4 3 2 1 0
Measuring range
(see table "Coding for measuring range")
Byte 4
7 6 5 4 3 2 1 0
Unassigned
Byte 5
7 6 5 4 3 2 1 0
0 0 0 0
Smooth scaling:
0000 = none
0001 = weak
0010 = medium
0011 = strong
Byte 6
7 6 5 4 3 2 1 0
0 0 0 0 0 0 0
Current limit for diagnostics wire break
(only for measuring type voltage (1 V to 5 V)
and current (4 mA to 20 mA)
0 = 1.185 mA
1= 3.6 mA

Figure B-1 Structure of data record 0: Bytes 0 to 6


Byte 7
7 6 5 4 3 2 1 0
0 0 0 0
Hardware interrupt, high limit 2*
Hardware interrupt, low limit 2*
Hardware interrupt, high limit 1*
Hardware interrupt, low limit 1*
Byte 8
7 6 5 4 3 2 1 0
0 0 0 0
Enable diagnostics:
Missing supply voltage L+
Wire break (only possible with measuring type: Voltage (1 to 5 V), current (4 to 20 mA)
Underflow
Overflow
Byte 9
Byte 11
7 6 5 4 3 2 1 0
Unassigned
Byte 12
Byte 13
15 14 13 12 11 10 9 8
7 6 5 4 3 2 1 0
Hardware interrupt, high limit 1** (see Table "Hardware interrupt limits for voltage and current")
Byte 14
Byte 15
Hardware interrupt, low limit 1** (see Table "Hardware interrupt limits for voltage and current")
Byte 16
Byte 17
Hardware interrupt, high limit 2** (see Table "Hardware interrupt limits for voltage and current")
Byte 18
Byte 19
Hardware interrupt, low limit 2** (see Table "Hardware interrupt limits for voltage and current")
Byte 20
Byte 27
Unassigned

* Enabling the hardware interrupts via data record is only possible when the channel is assigned a hardware interrupt OB in STEP 7

** High limit must be greater than the low limit

Figure B-2 Structure of data record 0: Bytes 7 to 27

Codes for measuring types

The following table lists all measuring types of the analog input module along with their codes. Enter these codes at byte 2 of the respective data record (see previous figure).

Table B- 2 Code for the measuring type

Measuring type	Code
Deactivated	0000 0000
Voltage	0000 0001
Current 4-wire transmitter	0000 0010
Current 2-wire transmitter	0000 0011

Codes for measuring ranges

The following table lists all measuring ranges of the analog input module along with their codes. Enter these codes at byte 3 of the respective data record (see previous figure).

Table B- 3 Code for the measuring range

Measuring range	Code
Voltage	
±5 V	0000 1000
±10 V	0000 1001
1 V to 5 V	0000 1010
Current 4-wire transmitter	
0 mA to 20 mA	0000 0010
4 mA to 20 mA	0000 0011
±20 mA	0000 0100
Current 2-wire transmitter	
4 mA to 20 mA	0000 0011

Hardware interrupt limits

The values that you can set for hardware interrupts (high/low limit) must not exceed the respective rated measuring range.

The following tables list the valid hardware interrupt limits. The limit values depend on the selected measuring type and range.

Table B- 4 Limits of hardware interrupts for voltage and current

Voltage		Current		
± 5 V, ± 10 V	1 V to 5 V	±20 mA	4 mA to 20 mA, 0 mA to 20 mA	
32510	32510	32510	32510	High limit
-32511	-4863	-32511	-4863	Low limit

Representation of analog values

C

Introduction

This chapter shows the analog values for all measuring ranges supported by the AI 8xU/I HS analog module.

Measured value resolution

Each analog value is written left aligned to the tags. The bits marked with "x" are set to "0".

Table C- 1 Resolution of the analog values

Resolution in bits including sign	Values		Analog value	
	Decimal	Hexadecimal	High byte	Low byte
16	1	1_H	Sign 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1

C.1 Representation of input ranges

The following tables set out the digitalized representation of the input ranges by bipolar and unipolar range. The resolution is 16 bits.

Table C- 2 Bipolar input ranges

Units	Measured value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32767	>117.589	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overshoot range
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Rated range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-27648	-100.000	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	
-27649	-100.004	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	Undershoot range
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
-32768	<-117.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

Table C- 3 Unipolar input ranges

Units	Measured value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32767	>117.589	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overshoot range
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Rated range
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Undershoot range
-4864	-17.593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	
-32768	<-17.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

C.2 Representation of analog values in voltage measuring ranges

The following tables list the decimal and hexadecimal values (codes) of the possible voltage measuring ranges.

Table C- 4 Voltage measuring range ±10 V and ±5 V

Values		Voltage measuring range		Range
dec	**hex**	**±10 V**	**±5 V**	
32767	7FFF	>11.759 V	>5.879 V	Overflow
32511	7EFF	11.759 V	5.879 V	Overshoot range
27649	6C01			
27648	6C00	10 V	5 V	Rated range
20736	5100	7.5 V	3.75 V	
1	1	361.7 µV	180.8 µV	
0	0	0 V	0 V	
-1	FFFF			
-20736	AF00	-7.5 V	-3.75 V	
-27648	9400	-10 V	-5 V	
-27649	93FF			Undershoot range
-32512	8100	-11.759 V	-5.879 V	
-32768	8000	< -11.759 V	< -5.879 V	Underflow

Table C- 5 Voltage measuring range 1 to 5 V

Values		Voltage measuring range	Range
dec	**hex**	**1 to 5 V**	
32767	7FFF	>5.704 V	Overflow
32511	7EFF	5.704 V	Overshoot range
27649	6C01		
27648	6C00	5 V	Rated range
20736	5100	4 V	
1	1	1 V + 144.7 µV	
0	0	1 V	
-1	FFFF		Undershoot range
-4864	ED00	0.296 V	
-32768	8000	< 0.296 V	Underflow

C.3 Representation of analog values in the current measuring ranges

The following tables list the decimal and hexadecimal values (codes) of the possible current measuring ranges.

Table C- 6 Current measuring range ±20 mA

Values		Current measuring range	
dec	**hex**	**±20 mA**	
32767	7FFF	>23.52 mA	Overflow
32511	7EFF	23.52 mA	Overshoot range
27649	6C01		
27648	6C00	20 mA	Rated range
20736	5100	15 mA	
1	1	723.4 nA	
0	0	0 mA	
-1	FFFF		
-20736	AF00	-15 mA	
-27648	9400	-20 mA	
-27649	93FF		Undershoot range
-32512	8100	-23.52 mA	
-32768	8000	< -23.52 mA	Underflow

Table C- 7 Current measuring ranges 0 to 20 mA and 4 to 20 mA

Values		Current measuring range		
dec	**hex**	**0 to 20 mA**	**4 to 20 mA**	
32767	7FFF	>23.52 mA	>22.81 mA	Overflow
32511	7EFF	23.52 mA	22.81 mA	Overshoot range
27649	6C01			
27648	6C00	20 mA	20 mA	Rated range
20736	5100	15 mA	16 mA	
1	1	723.4 nA	4 mA + 578.7 nA	
0	0	0 mA	4 mA	
-1	FFFF			Undershoot range
-4864	ED00	-3.52 mA	1.185 mA	
-32768	8000	<- 3.52 mA	< 1.185 mA	Underflow

C.4 Measured values for wire break diagnostic

Measured values on diagnostic event "wire break", dependent on diagnostics enables

Error events initiate a diagnostics entry and trigger a diagnostics interrupt if configured accordingly.

Table C- 8 Measured values for wire break diagnostic

Format	Parameter assignment	Measured values		Explanation
S7	• "Wire break" diagnostics enabled • "Overflow/Underflow" diagnostics enabled or disabled ("Wire break" diagnostics takes priority over "Overflow/Underflow" diagnostics)	32767	$7FFF_H$	"Wire break" or "Open circuit" diagnostic alarm
	• "Wire break" diagnostics disabled • "Overflow/Underflow" diagnostics enabled	-32767	8000_H	• Measured value after leaving the undershoot range • Diagnostic alarm "Low limit violated"
	• "Wire break" diagnostics disabled • "Overflow/Underflow" diagnostics disabled	-32767	8000_H	Measured value after leaving the undershoot range

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D

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